HRS Detector Package for PREX-II/CREX

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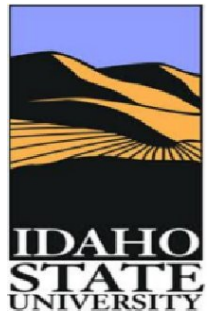
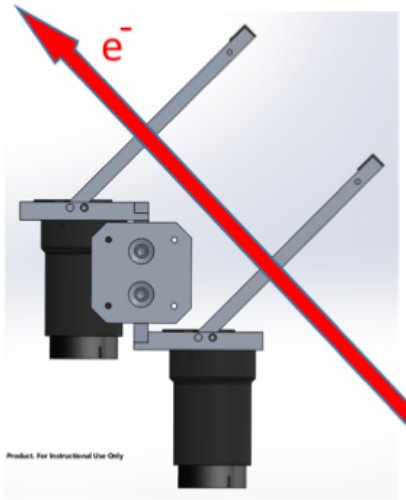


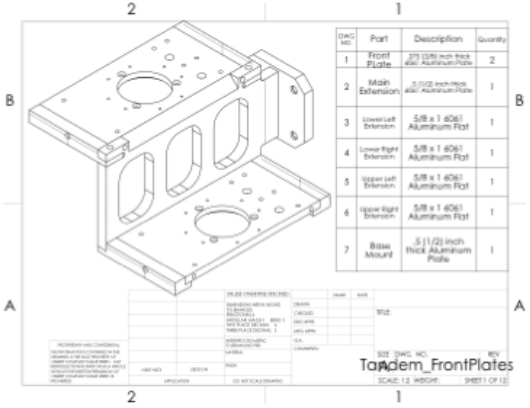
HRS Detector Package for PREX-II/CREX

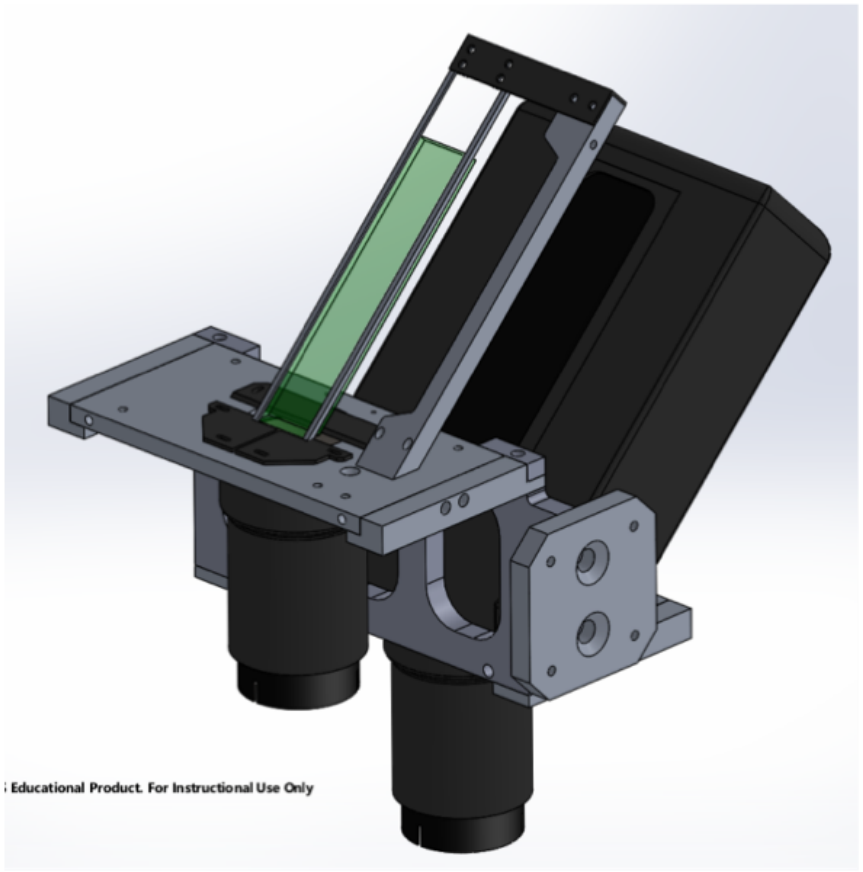
Talk Outline:

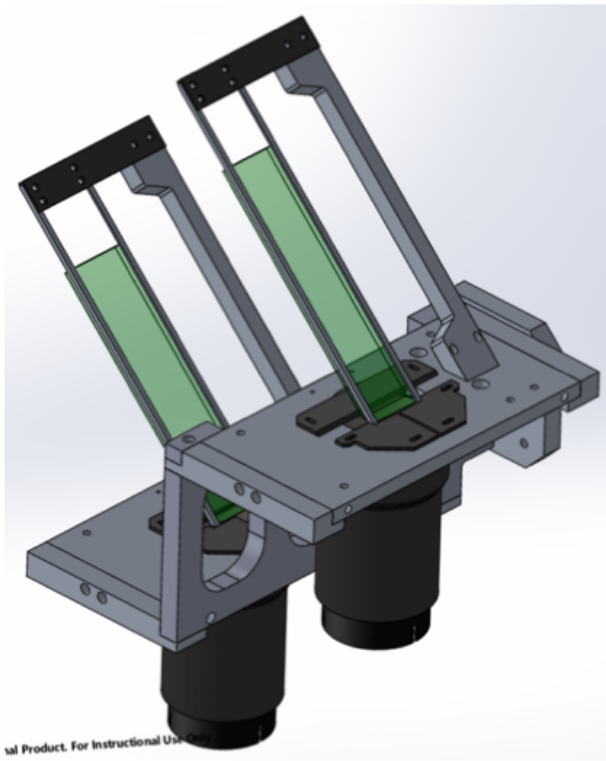
- Tandem Detector Design Update
- GEM Tracking System Update
- GEM Stand with Tandem Mount Update
- HRS Detector Package
- Summary and Future Work

Main Integrating Tandem Detector Design



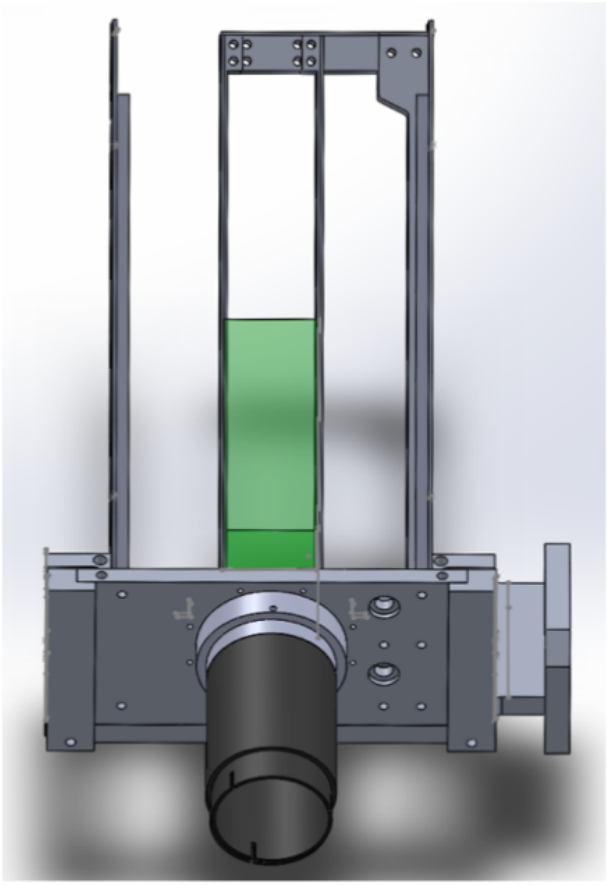




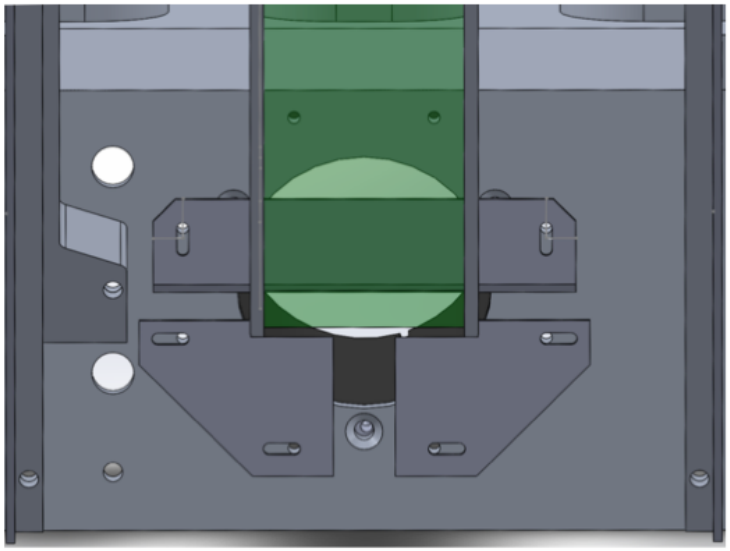


- PREX-II/CREX main detector design based on UMass Design-3.
- Rotatable tandem mount designed and prototype constructed
- New design has shorter quartz rails and incorporates mu-metal shields and 3D printed Nylon enclosure with Kapton windows

Quartz Geometry Plans (Preliminary)



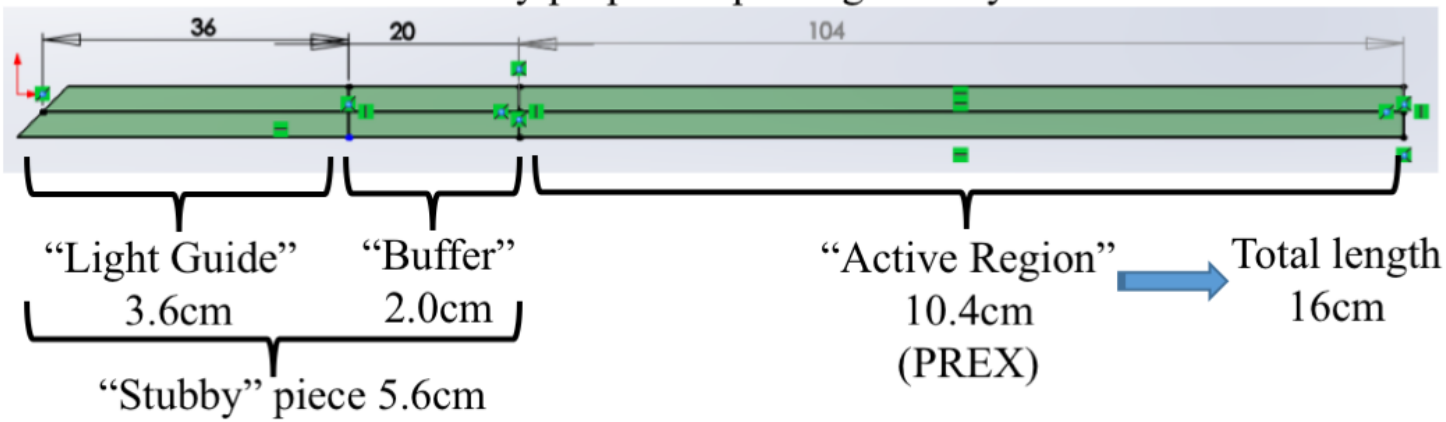
Beam's view. Note "stubby" quartz installed upstream, "full" quartz downstream – for illustrative purposes



Top view showing quartz-rail supports (at PMT end). No light guides or wrapping will be used.

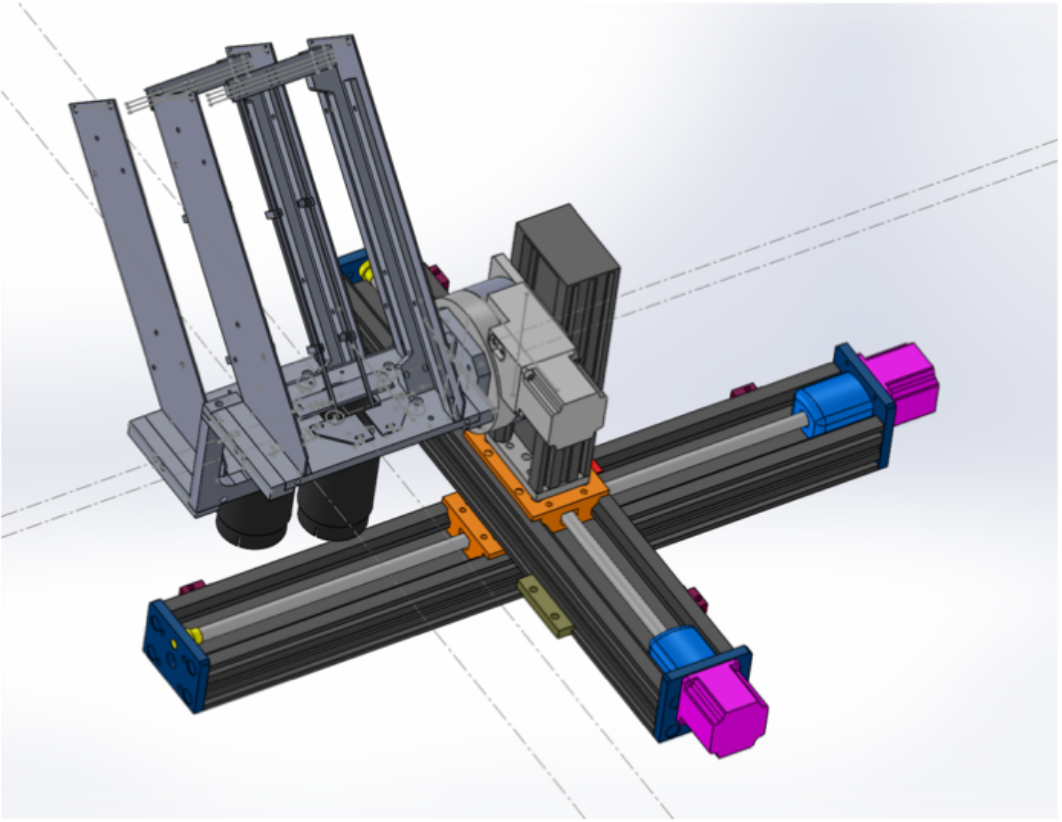
- PREX-I quartz was 3.5 cm wide by 16 cm long by 6 mm/10 mm thick
- PREX-II and CREX quartz could be same geometry as PREX-I
- Design can accommodate up to 4.8 cm wide quartz piece

Preliminary proposed quartz geometry idea

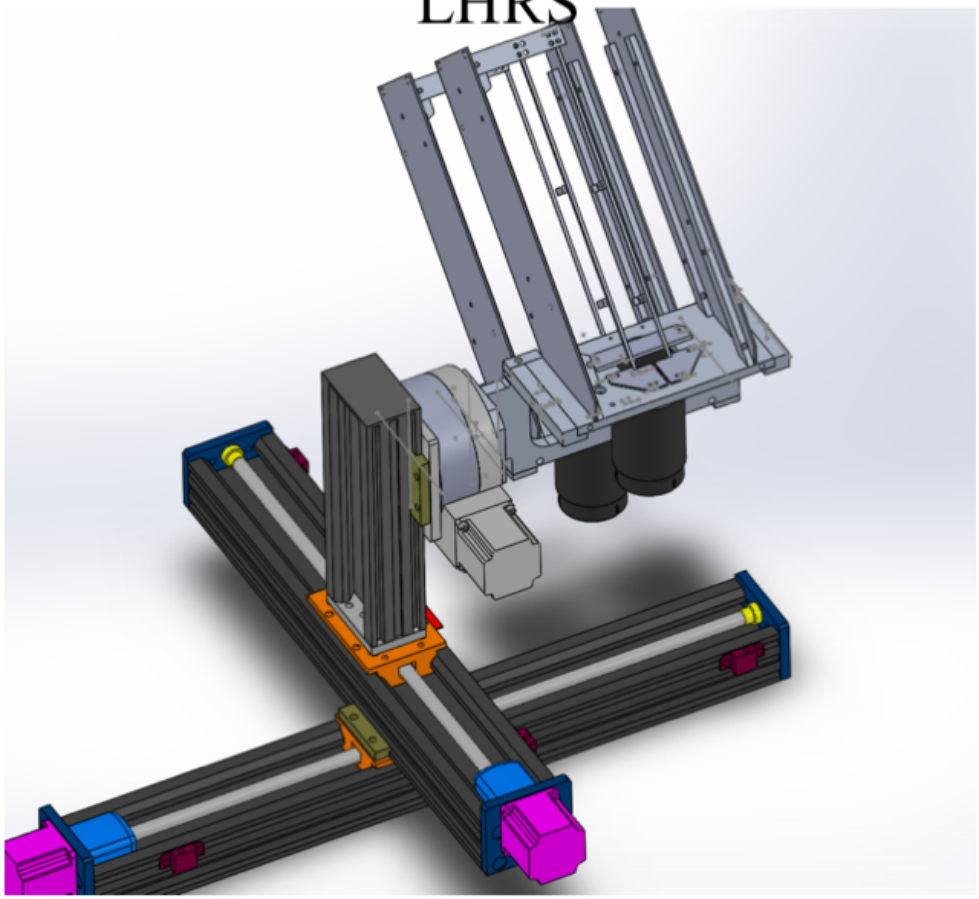


Prototype Tandem Mount (Degrees of Freedom)

RHRS

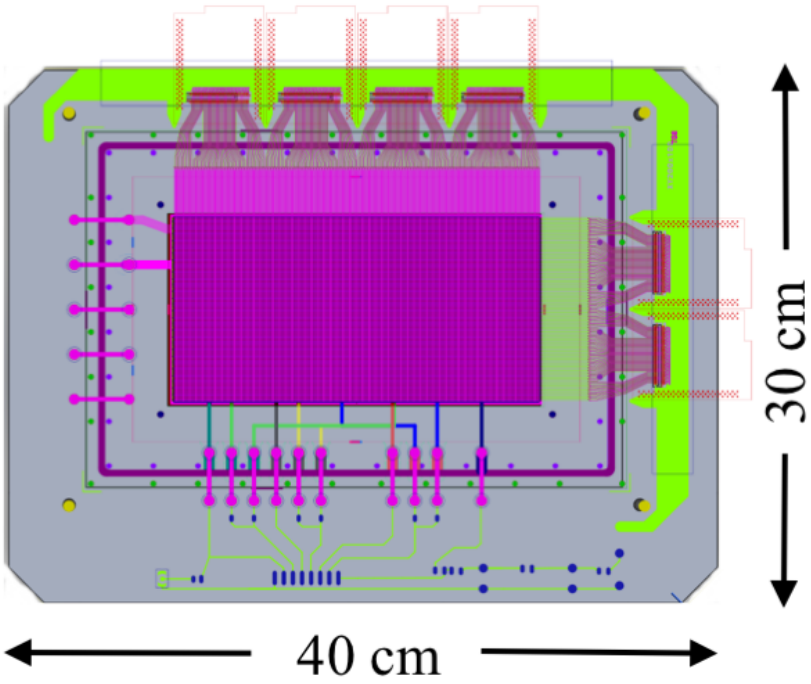


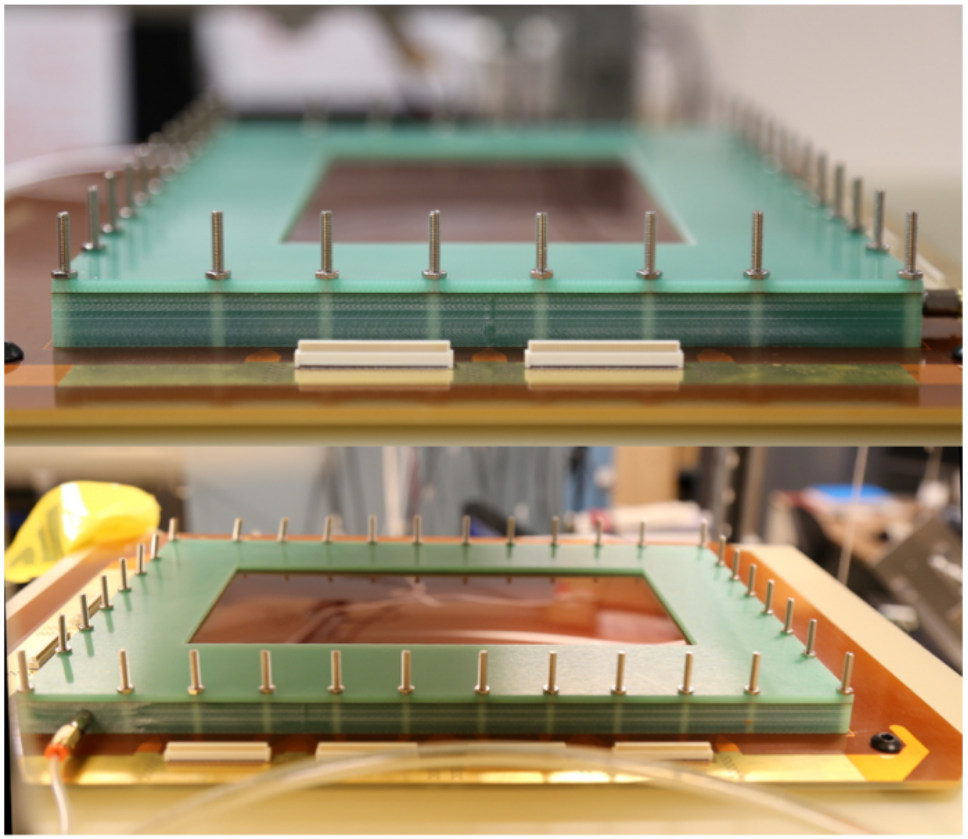
LHRS



- *X*, *Y*, and θ degrees of freedom
- Velmex 5 and 10 inch travel sliders (Jack has from PREX-I) and rotary stage (have one, *need another*)

PREX/CREX "small" 10x20 cm^2 GEM trackers

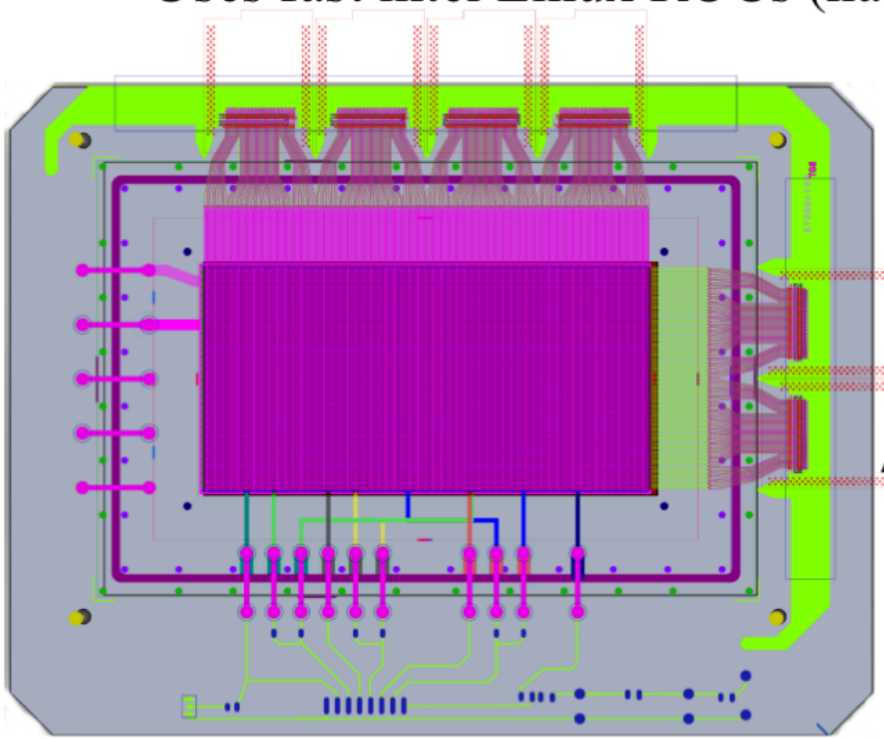


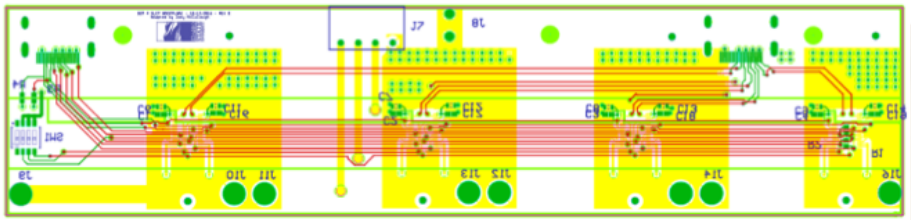


- Custom CERN 10 cm by 20 cm active area triple GEM chambers
  - 400μm pitch x/y, 4 + 2 Panasonic 130pin Readout connectors
  - Standard GEM spacing D-3mm-G1-2mm-G2-2mm-G3-2mm-RO
  - Standard HV filter circuit: uses CERN ceramic resistor
- Readout scheme based on INFN/UVA SBS rear-tracker:
  APV25FE ➟ backplane PCB ➟ VME MPD

GEM Readout Plans

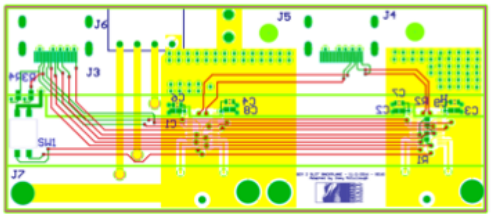
- GEM readout scheme based on INFN/UVA SBS rear-tracker system:
  - Uses APV25FE rev4.1 cards (have 55 in-hand); each chamber requires 6 APVs
  - Requires new 4-slot and 2-slot "backplane" PCBs (have 36 in-hand)
  - Backplanes buss analog-out signals to MPD and pass digital ctrl signals to APVs
  - Have 6 VME MPDs (Multi-Purpose Digitizers); require 2 for each arm
  - Uses fast intel Linux ROCs (have 3 in-hand: GE XVB601); require 1 for each arm





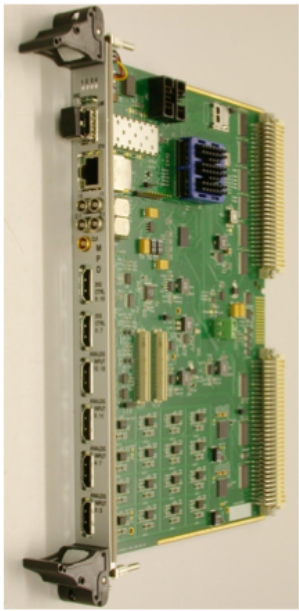
4-slot backplane

APV rev4.1



2-slot backplane

APVs mount directly to Panasonics on GEM readout board—amplifies and multiplexes output



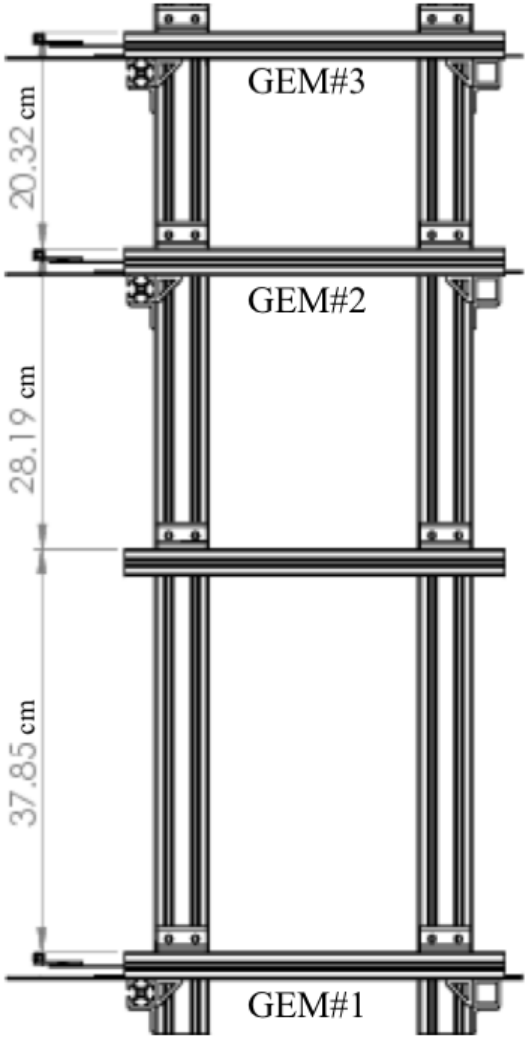
MPD rev4: Handles 16 APVs

- Getting much advice and help from Paolo Musico and INFN group, Kondo Gnanvo, Chris Cuevas, Nilanga Liyanage, and Alexandre Camsonne

GEM DAQ Plans

- Each arm requires one VME crate with fast linux ROC and at least three other available slots; I am currently using two Dawn 4-slot VME crates
- Each arm will need a trigger interrupt module and 2 MPDs; I am currently using SIS3610 and a CEAN V965 QDC for triggering interrupts (*we will likely want/need JLab TIs for this*)
- Using CODA 2.6.2 with MPD drivers and support from JLab DAQ group
- Planning to use 6 – 10 meter long high speed HDMI cables for analog and digital signals
- Each arm will need a CAEN N1470 HV NIM module with 3 available channels; I currently have only one HV module (*I will need to borrow another*)
- Each arm will need LV power supply with 5.0, 2.5 and 1.25 V; I have one already built and plan to build another

GEM Chamber Mounting Concept



Aluminum ladder-frame

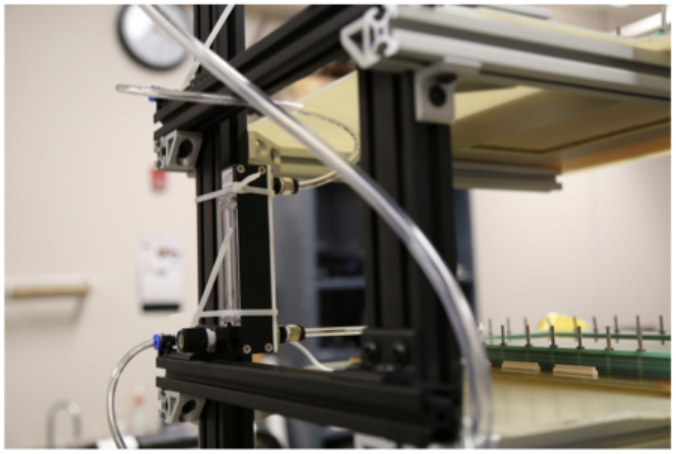
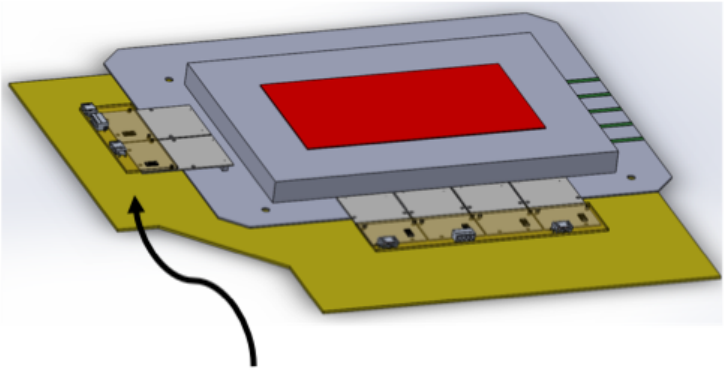
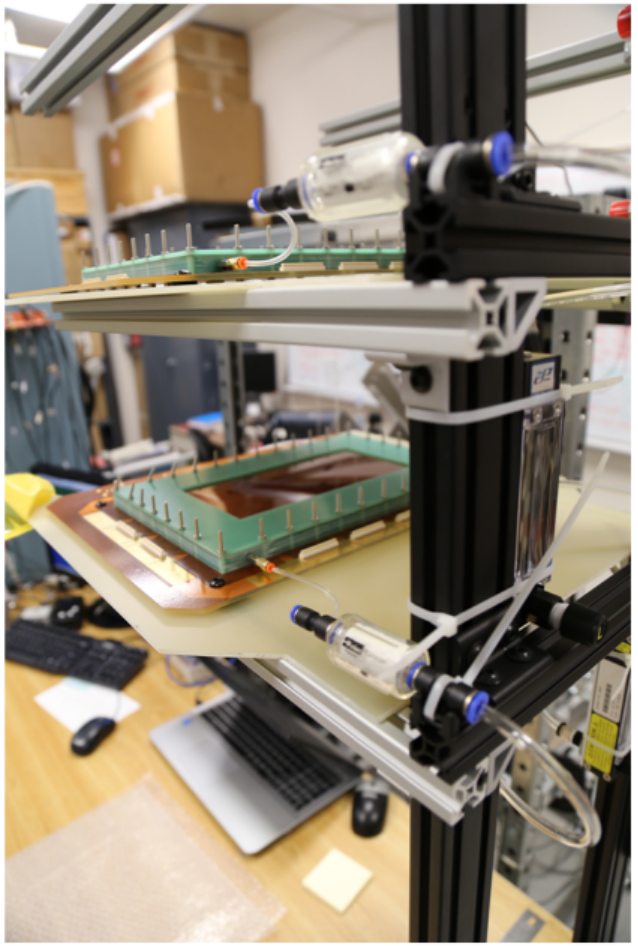


Photo showing rail support brackets



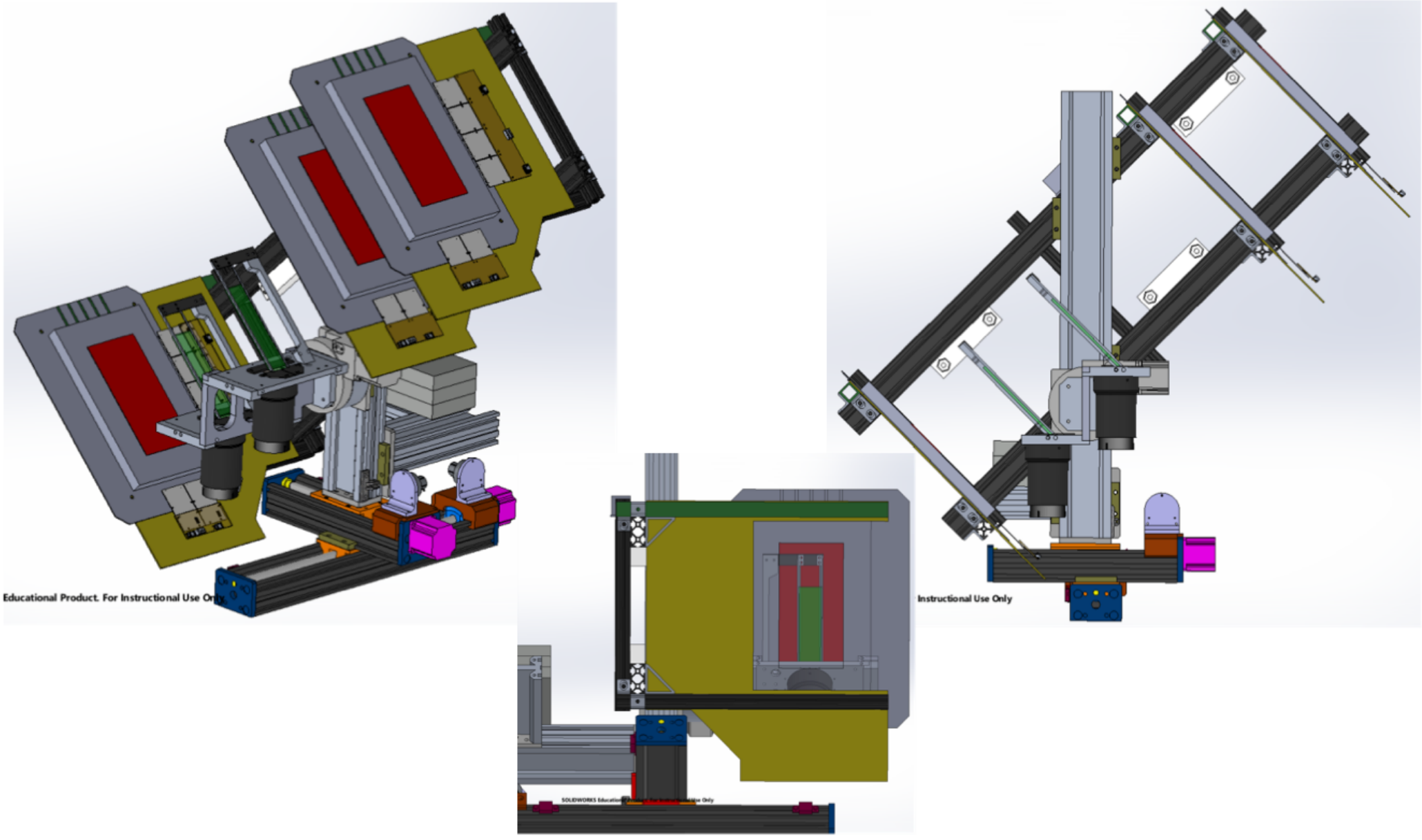
G10 platforms (1/16 in. thick) for GEMs: supports readout electronics



Two Chambers installed; gas flowing

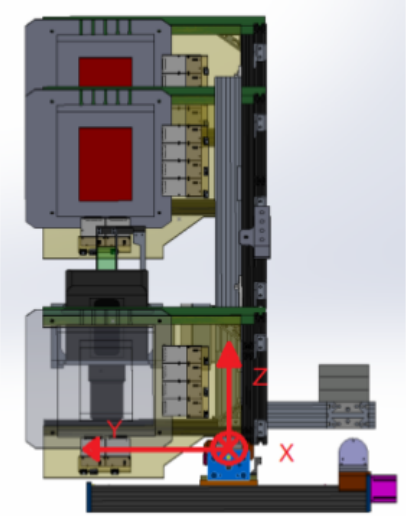
- 1" Extruded aluminum framing system for GEM mount; not finalized yet
- Each arm will use three GEM chambers: one upstream and two downstream of quartz
- GEM ladder-frame mounts to Velmex slider post using cleats

RHRS Tandem Quartz Mount with GEMs



Electron's view (from below)

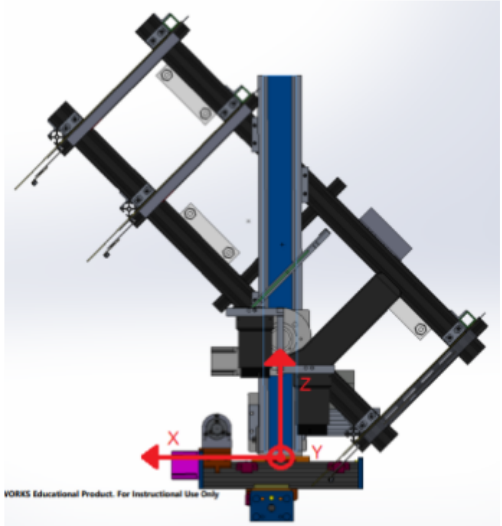
HRS Detector Package Torque Analysis

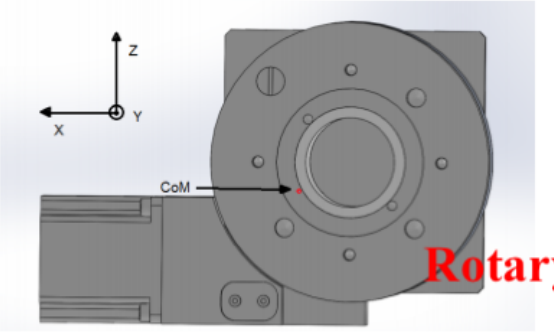


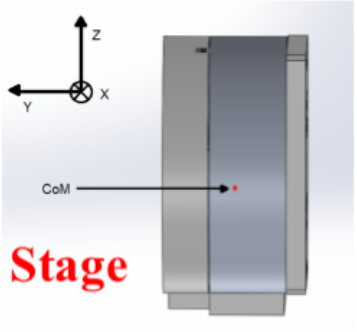
Using HRS hut coordinate system

- Origin defined at the center of the 5-inch travel (top) slider platform.

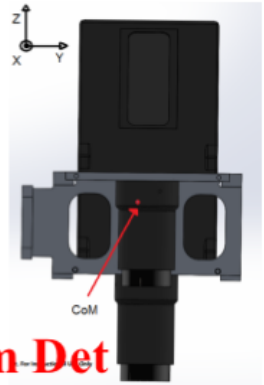
Center of Mass Analysis



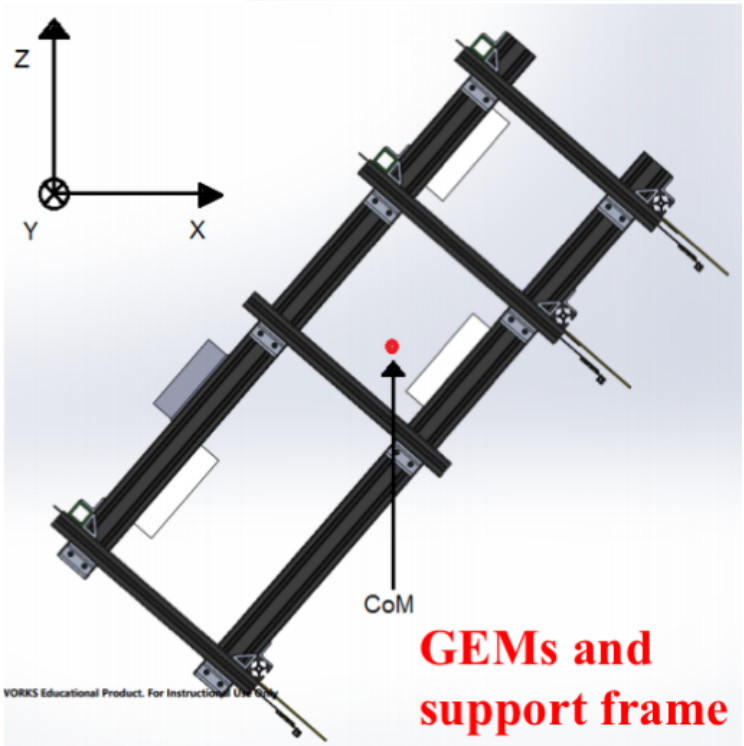




Rotary Stage

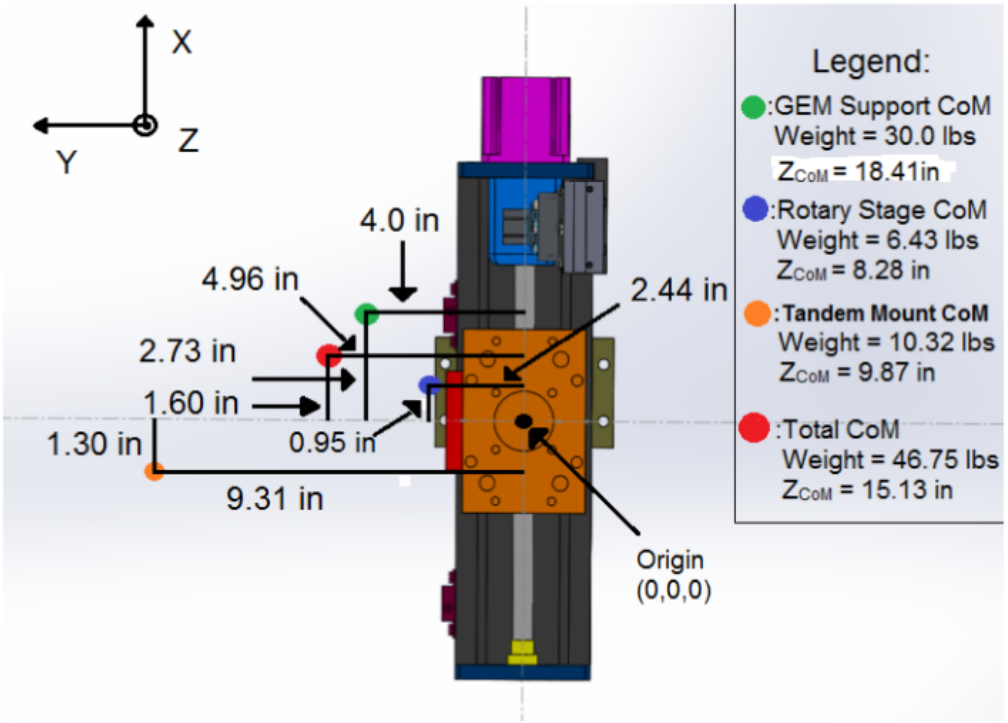


Tandem Det



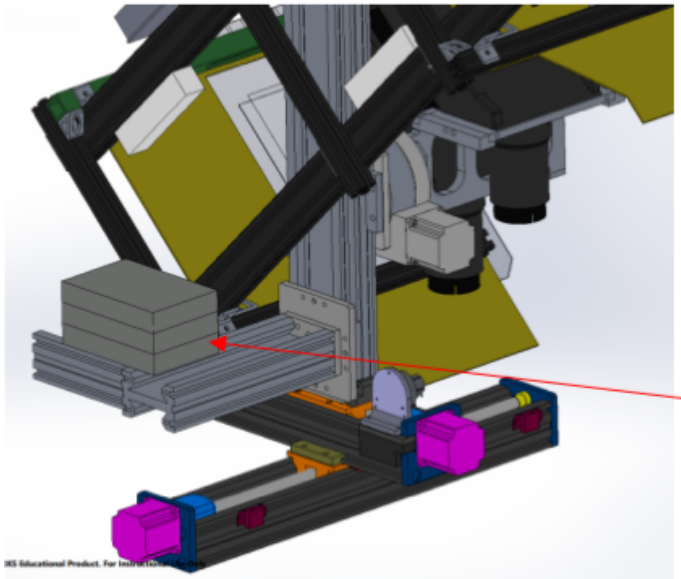
GEMs and support frame

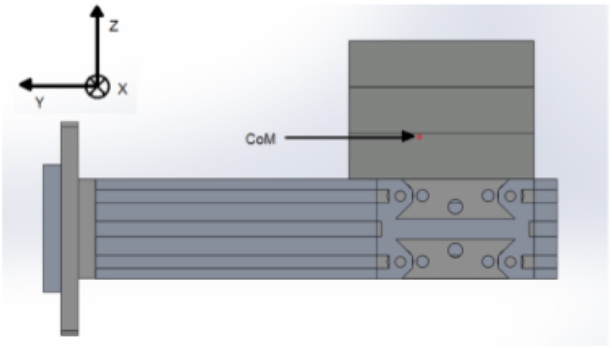
HRS Detector Package Torque Analysis

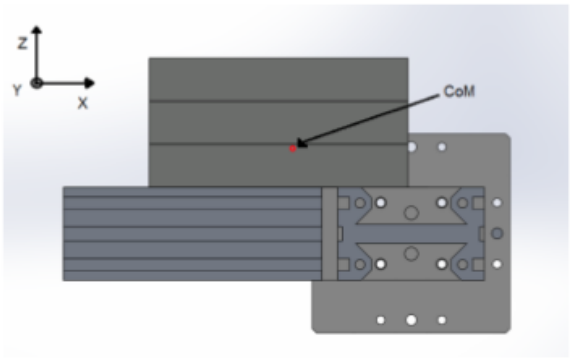


Dot Color	Assembly	Weight (lbs)	Torque around y-axis (in-lbs)	Torque around x-axis (in-lbs)
Green	GEM Support Frame	30.0	81.90	-120.0
Blue	Rotary Stage	6.43	6.11	-15.69
Orange	Tandem Quartz Mount	10.32	-13.42	-96.08
Red	**Total Detector Package**	**46.75**	**74.59**	**-231.77**

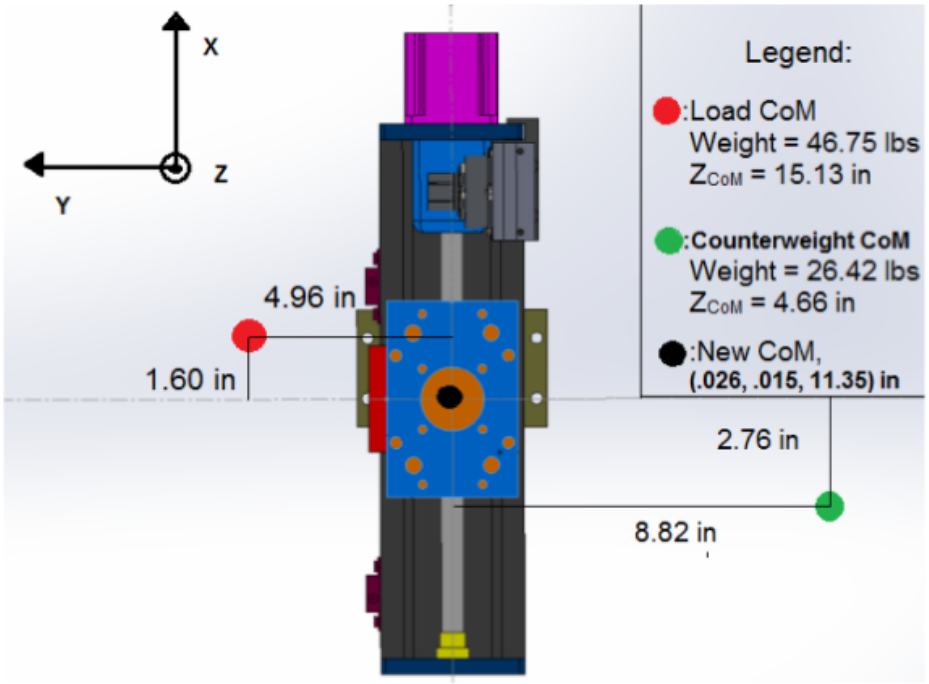
HRS Detector Package Torque Analysis







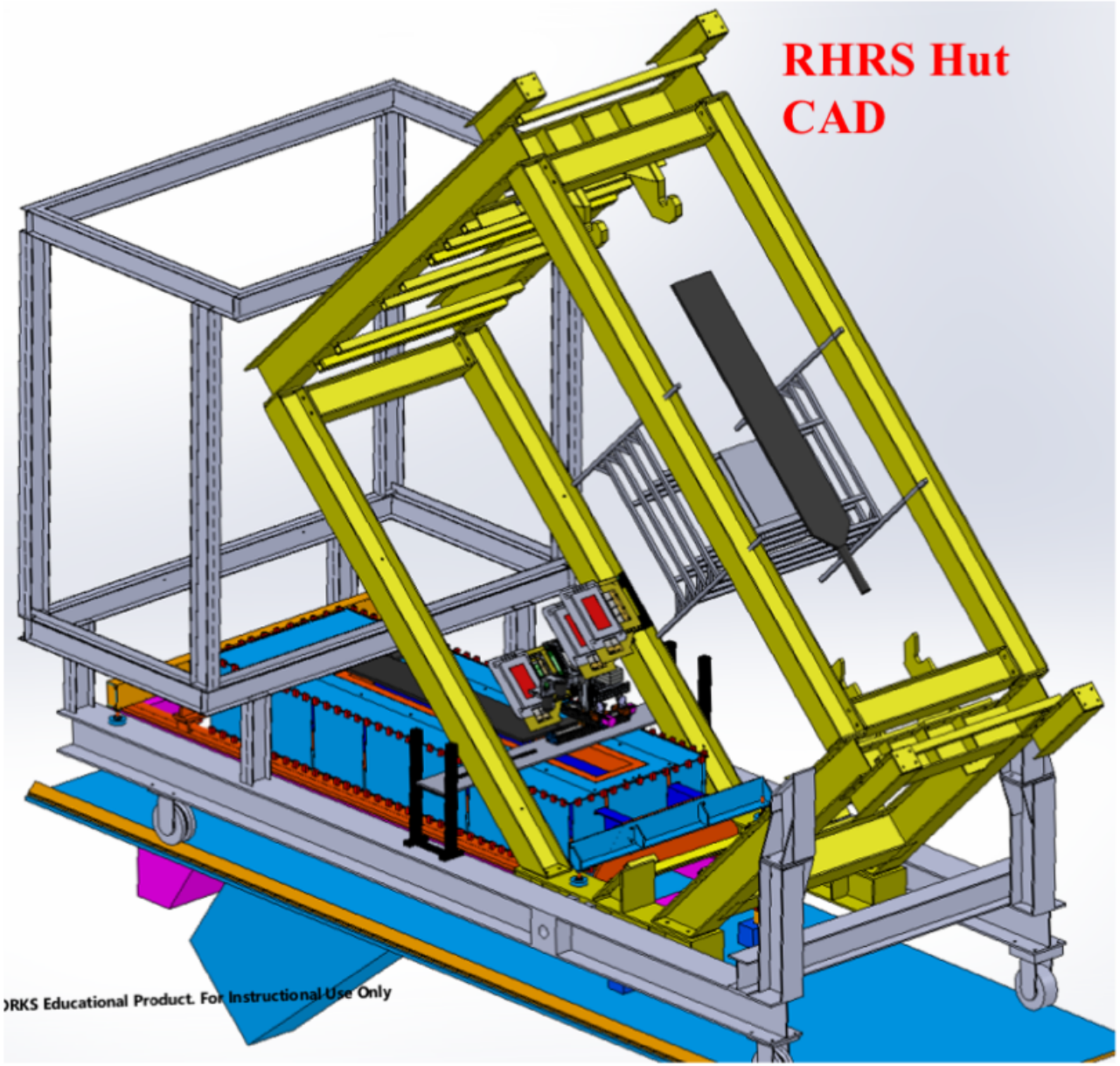
Counter weight (+ supports): 26.4 lbs



- Using the new center of mass location and new load (old load + counterweight) of **73.17 lbs**, net torques were calculated.
- Net Torque about X-axis: (0.015 in)*(73.17 lbs) = **1.10 in-lbs**
- Net Torque about Y-axis: (0.026 in)*(73.17 lbs) = **1.90 in-lbs**
- Net Total Torque: $((1.10)^2+(1.90)^2)^{1/2}$ = **2.19 in-lbs**

HRS Detector Package for PREX-II/CREX

- All HRS standard detector packages removed except for VDCs: No S1, S2, Cerenkov, or Calorimeter
- For counting-mode operation: Use S0 + S3 for triggering
- Additional array of large GEMs from UVA group installed above PREX detector package
- A_T detector not shown: will mount just above small GEMs
- Plan to reuse same hardware and mounting/installation concept developed for PREX-I



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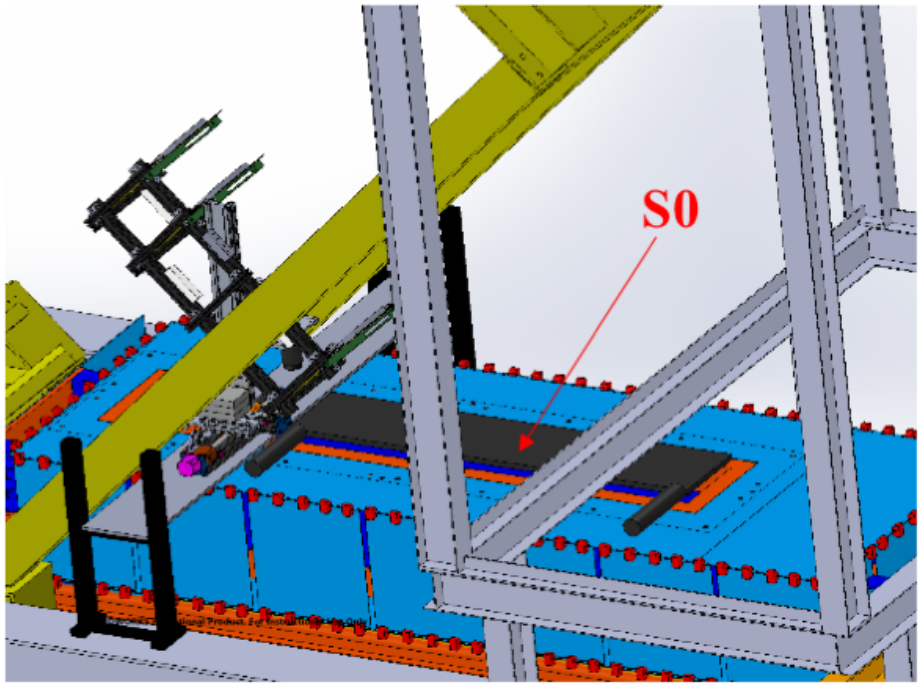
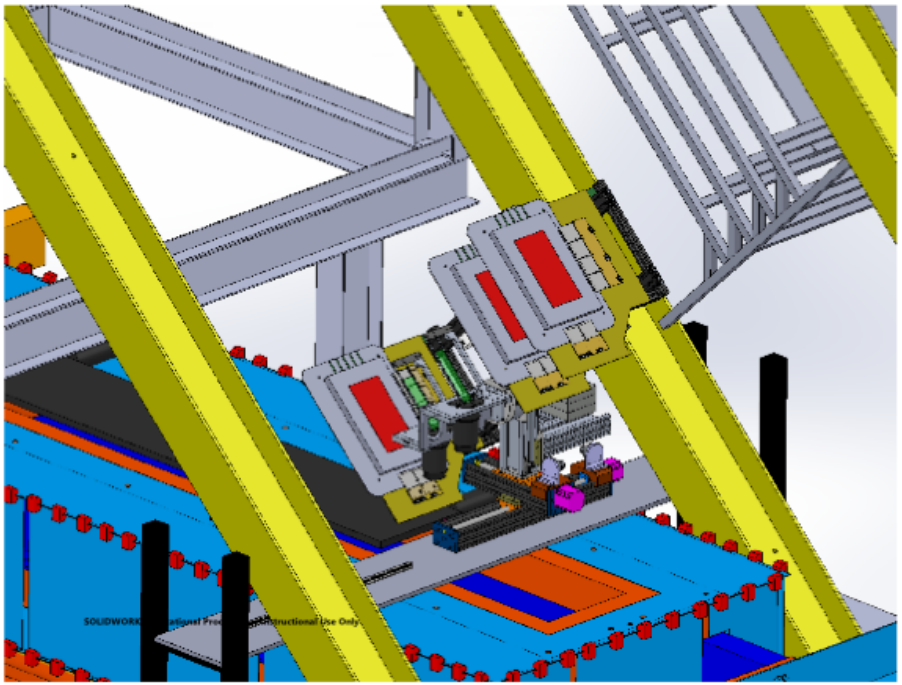
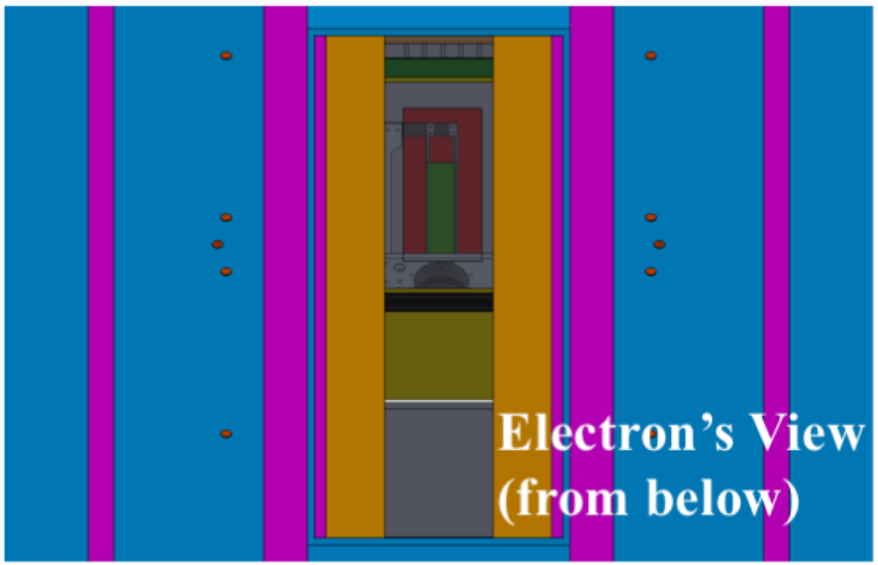
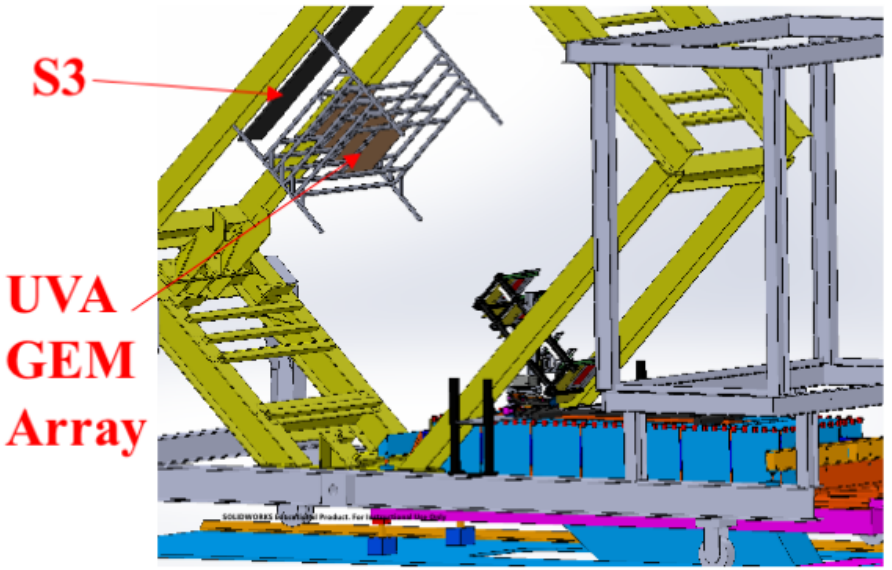








Main Detector Summary

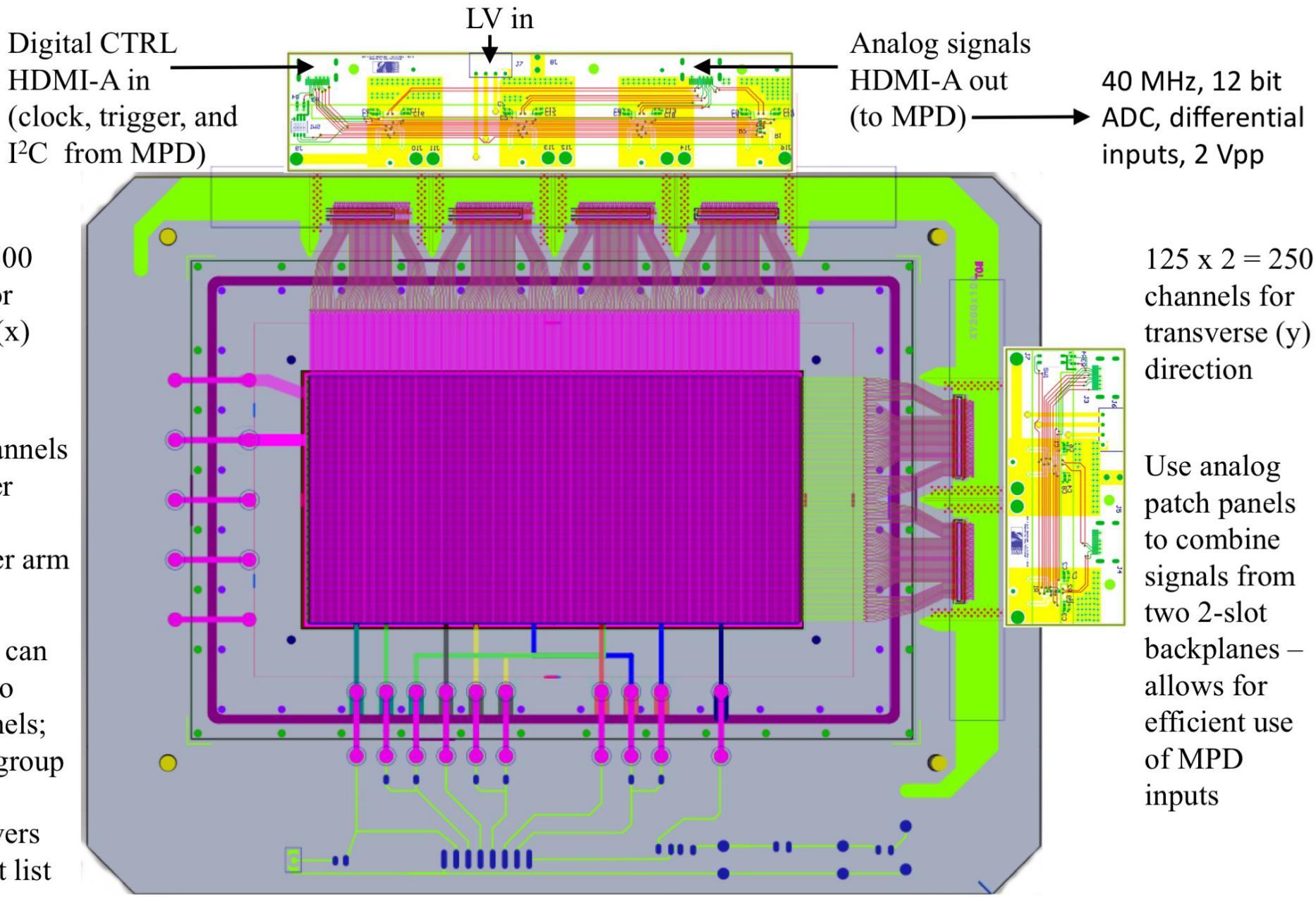
- PREX-II/CREX main detector design essentially complete
  - Waiting for *final* PREX-II and CREX focal-plane footprints before finalizing quartz geometry
  - Will use bare, unwrapped quartz and no light guide
  - Rotary tandem mount concept vetted: Left arm tandem detector constructed and in cosmic test-stand
- Main detector PE yields and relative widths measured at MAMI for 6mm/10mm thick tandem
  - Tyler and Carlos Bula will give details of testbeam results: For unwrapped quartz, 6mm gives 37 peak PEs with 20% RMS/Mean; 10mm gives 65 peak PEs with 17% RMS/Mean
  - Expected focal plane rates times these peak PE calibrations give PMT photocathode light levels–so we can prepare each PMT for optimal linearity–Devi will give progress update

GEM Summary

- "Small" GEM tracking system development underway
  - 5 assembled and tested GEM chambers in hand (*need at least one more chamber*)
  - All readout electronics in hand: 55 APVs, 6 MPDs, 20 two-slot and 16 four-slot backplanes
  - GEM mounting concept developed and prototype built
  - HV circuits assembled and burn-in procedure completed
  - CODA DAQ with MPD drivers established; communicating with APVs; need to incorporate custom trigger interrupt routine for our hardware; start exploring basic functionality and cosmic-ray/source tests
- Thanks to ISU parity group: Carlos Bula-Villarreal, Devi-Adhikari, Joey McCullough, Daniel Sluder, and Brady Lowe

Extra Slides

GEM Readout


LV in
Digital CTRL
HDMI-A in
(clock, trigger, and
I²C from MPD)
Analog signals
HDMI-A out
(to MPD)
40 MHz, 12 bit
ADC, differential
inputs, 2 Vpp
125 x 4 = 500
channels for
dispersive (x)
direction
750 x/y channels
per chamber
gives 3000
channels per arm
Each MPD can
handle up to
2000 channels;
Jlab DAQ group
support for
CODA drivers
and readout list
125 x 2 = 250
channels for
transverse (y)
direction
Use analog
patch panels
to combine
signals from
two 2-slot
backplanes –
allows for
efficient use
of MPD
inputs

Detector Configuration in HRS (Top View)